THE CHANGING DISTRIBUTION OF THE GENUS *NAJAS* (NAJADACEAE) IN OHIO[1, 2]

W. ALAN WENTZ AND RONALD L. STUCKEY

College of Biological Sciences, The Ohio State University, Columbus 43210

ABSTRACT

Over the past 70 years, the distributions of the species in the genus *Najas* in Ohio have undergone changes. *Najas gracillima* and *N. flexilis*, native species of northern, cool, clear waters, have disappeared or become reduced in abundance, while *N. marina* and *N. minor*, European species, and *N. guadalupensis*, a southern native species, have invaded, spread, and/or have become more common in the state. Factors apparently responsible for these changes are (1) an increase in the numbers of artificial ponds and lakes, (2) an increase in the turbidity of Ohio waters, and (3) a gradual warming and overall general eutrophication of Ohio river and lake waters. Dated dot-distribution maps show the Ohio distributions of these species. Notes on the distribution of the species in nearby states are given.

The genus *Najas* comprises those delicate underwater plants similar in certain respects to the more familiar and more common aquatic plants, the pondweeds (*Potamogeton*), but differing most obviously in their opposite leaves. The distribution of *Najas* in Ohio is treated in a recent publication (Braun, 1967) and in an older paper (Clausen, 1936). However, the maps presented in these publications are inadequate, because certain critical herbarium specimens were overlooked and because some specimens to which they referred had been misidentified. In addition, the distributions of the species are undergoing changes, as shown by data from our recent field work on aquatic plants in central and northwestern Ohio, and by a study of the available herbarium specimens. Five species of *Najas*, *N. gracillima*, *N. flexilis*, *N. marina*, *N. guadalupensis*, and *N. minor*, are known in Ohio. Specimens in The Ohio State University Herbarium reveal that *N. gracillima* was collected in the state as early as 1898, *N. minor* as early as 1932, and *N. marina* not until 1959.

The identification of specimens of *Najas* can be difficult. Whenever possible, specimens should be collected during fruiting, because the shape and surface markings of the fruit and the length of the mature style are the most dependable characters for identification. Owing to the variability of individual plants within a species, it is best that any single specimen be identified on the basis of at least two characters, preferably one vegetative and one reproductive. Caution must be especially exercised when identifying specimens in vegetative condition. For example, *N. minor* superficially resembles *N. gracillima* in early growth stages, and the often-mentioned recurved-leaf character of *N. minor* usually does not appear until late in the growing season, during August, September, or October. Reliable keys and illustrations have been presented by Fassett (1957) and by Braun (1967).

A brief discussion of the distribution and general ecology of each species of *Najas* in Ohio follows. Distribution maps and cited voucher herbarium specimens accompany the discussion of each species. All herbarium specimens of *Najas* have been studied from the following Ohio herbaria, most of whose identities are given by the abbreviations in Lanjouw and Stafleu (1964): Bowling Green State University (BGSU), Denison University (DEN), Franz Theodore Stone Laboratory (FTSL), Kent State University (KE), Miami University (MU), Oberlin College

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(OC), The Ohio State University (OS), and Ohio University (BHO). A few additional specimens or specimen records have been cited from the herbaria of Butler University (BUT), the Cranbrook Institute of Science (BLH), Central Michigan University (CMC), the Illinois Natural History Survey (ILLS), Indiana University (IND), The University of Michigan (MICH), Michigan State University (MSC), the New York Botanical Garden (NY), the United States National Museum (US), and West Virginia University (WVA).

Najas gracillima (A. Br.) Magnus

Najas gracillima occurs on the North Atlantic Coastal Plain and inland in the Great Lakes region. According to Clausen (1936), the inland distribution in 1936 was limited to Wisconsin and Minnesota. However, *N. gracillima* has been known from specimens in Ohio since 1898, but has not been collected since 1918 and probably does not occur in the state today. Three collections, all from the northern part of the state, are known to have been made from natural lakes and ponds in Ottawa, Portage, and Wayne Counties (fig. 1). These locations are within the expected range of species other than *Najas* that occur both on the North Atlantic Coastal Plain and inland about the Great Lakes region, primarily north of the glacial boundary. Examination of the specimens (at OS) from Adams, Brown, Clermont, and Clinton Counties, used as a basis for mapping by Braun (1967), shows that they are really young plants of *N. minor* (the morphological differences between these two species are summarized in the discussion of *N. minor*).

Since the time of Clausen's work (1936), *N. gracillima* has been found in Michigan (specimens seen at MICH), Illinois (Fore and Mohlenbrock, 1966), Indiana (Deam, 1940), and Missouri (Steyermark, 1963). The specimens of *N. gracillima* collected in 1952 and 1961 from Illinois (Fore and Mohlenbrock, 1966) are only partially correctly identified. We have had access to two of the cited specimens; the one from Ford County (*Hiltibran*, ILLS) is *N. minor*, and the one from Williamson County (*Evers 34356B*, ILLS) is a mixture of *N. minor* and *N. gracillima*. The specimen collected in 1935 (*Kriebel 3477*, IND) and cited by Deam (1940) from Lawrence County in southern Indiana is correctly identified. *Najas gracillima* has recently been found in southern Indiana (Jackson County) in Knob Lake (7 Sep 1958, *Starcs 2123*, BUT; 19 Jul 1970, *Starcs 3100*, BUT, OS). The plants collected in 1937 and 1939 from Missouri (Steyermark, 1963) are probably correctly identified, although we have not examined these specimens.

Ohio specimens examined:

OTTAWA CO.: Portage River near Port Clinton, 20 Aug 1898, *Pieters* (BGSU, MICH). PORTAGE CO.: 3–6 ft of water, Sandy Lake, 3 Aug 1918, *Hopkins* (OS). WAYNE CO.: Doner's Lake, 21 Jul 1899, *Selby* (OS).

Najas flexilis (Willd.) Rostk. & Schmidt

Najas flexilis, once probably the most common and widespread naiad in Ohio, is now apparently becoming rare. A native northern species in its total distribution, in Ohio its occurrence is primarily in natural lakes north of the Wisconsin glacial boundary (fig. 1). *Najas flexilis* is a species that usually occurs in clear, cool waters, and has been collected from fewer than 12 locations in the state during the past 20 years. We have not been successful in attempts to find *N. flexilis* in localities in central and western Ohio where it was collected at the turn of the century. Locations that have been checked are Buckeye Lake, Brush Lake, Indian Lake, Grand Lake St. Marys, Sandusky Bay, and Put-in-Bay harbor in Lake Erie. In many of these places, the water is now quite muddy or turbid. *Najas flexilis* has, however, been found in recent years at East Harbor along Lake Erie, where it occurs in shallow, temporary pools on an extensive sand-mud flat formed by deposition of bottom dredgings in 1968. Other contemporary collections come from the extreme northern part of the state in Williams, Ottawa, Erie, Huron, Lorain, and Portage Counties, and in the central western part of the

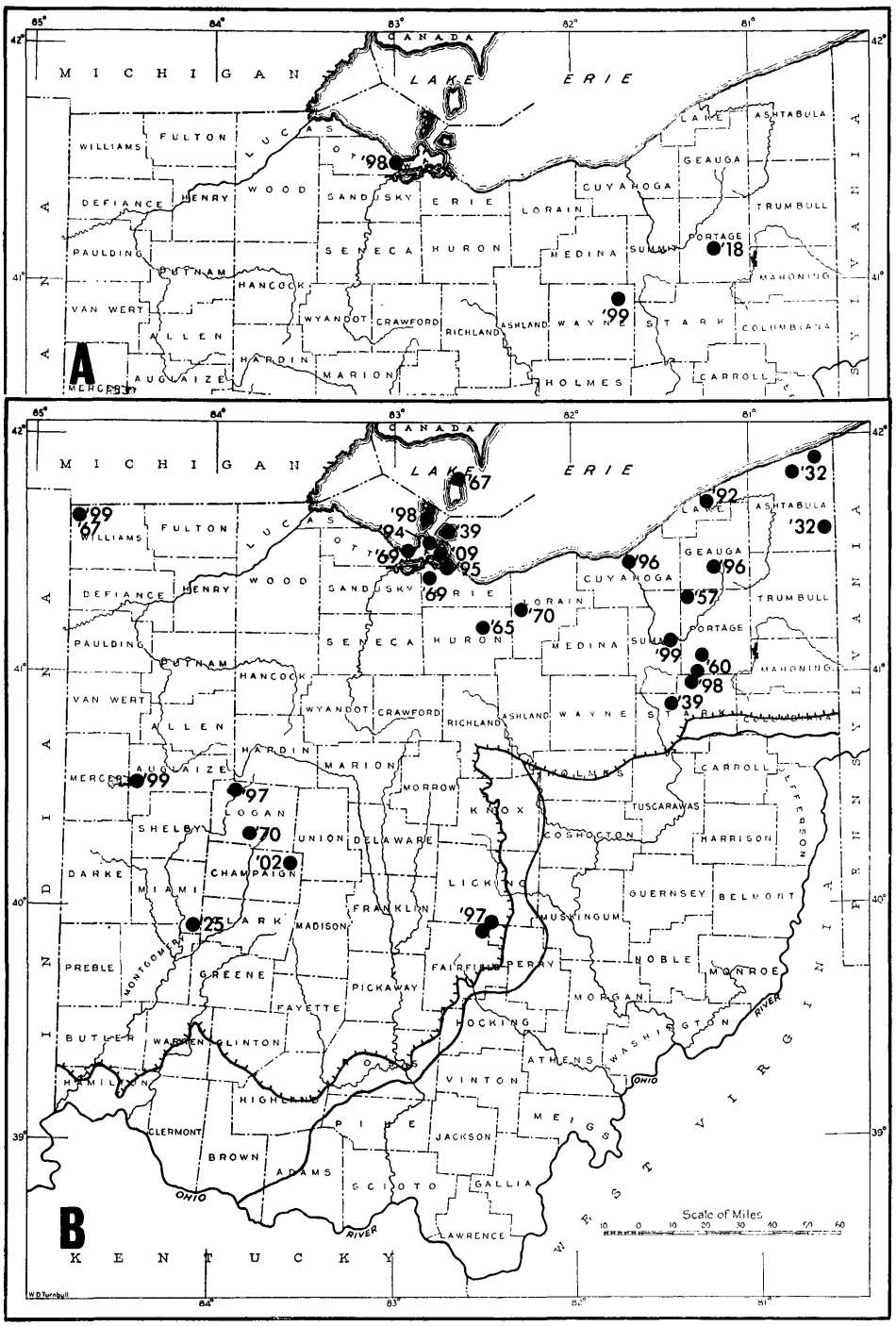

FIGURE 1. Distribution of *Najas gracillima* (A) and *Najas flexilis* (B) in Ohio based on all specimens examined. The single line represents the maximum extent of continental Pleistocene glaciation; the hashured line represents the maximum extent of Wisconsin glaciation. Each specimen is mapped by a dot at each locality and by the last two digits of the year in which it was collected.

state at Doke Lake in Logan County. Most of these location sites are man-made ponds or natural lakes where the water is relatively clear.

Ohio specimens examined:

ASHTABULA CO.: In ponds along the Conneaut River, near Farnham, 16 Jul 1929, *Hicks* (OS); E. Andover Twp., 19 Jun 1932, *Hicks* (OS); pond at Kingsville, 20 Aug 1932, *Hicks* (OS); pond 2 mi sw of Ashtabula, 23 Aug 1932, *Hicks* (OS). AUGLAIZE CO.: Ponds, St. Marys, Ohio, 13 Jun 1899, *Wetzstein* (OC). CHAMPAIGN CO.: Brush Lake, 20 May 1902, *Schaffner* (OS). CUYAHOGA CO.: Cleveland, 1896, *Claassen* (OS). ERIE CO.: Sandusky, 20 Jul 1895, *Moseley* (OS); in beach channel, Cedar Point, 17 Jul [ca. 1909], *C. A. D*[*avies*] (DEN); Kelleys Island, 11 Aug 1939, *Core* (FTSL); occasional in shallow water on s edge of marl pond on w side of N–S road in the sw corner of the Resthaven Wildlife Area (Castalia Prairie), ca. 1 mi w of Castalia, 19 Aug 1969, *Stuckey 8243* (OS). FAIRFIELD CO.: Lakeside, 21 Jul 1897, *Kellerman* (OS). GEAUGA CO.: Punderson's Lake, 1896, *Claassen* (OS). HURON CO.: Shallow pond in gravel pit, DeRussey Rd., Hartland Twp., 6 Sep 1965, *Jones* (OC). LAKE CO.: Painesville, 23 Aug 1892, *Werner* (OS). LICKING CO.: Licking Reservoir, 22 Jul 1897, *Kellerman* (OS). LOGAN CO.: Lewistown Reservoir, 22 Aug 1897, *Kellerman & Beatty* (OS); locally common in shallow water along edge of northwest corner of Doke Lake, east edge of Union Twp., ca. 6.5 mi e of DeGraff, 25 Sep 1970, *Stuckey 9314* (OS). LORAIN CO.: Abundant at boat launch ramp, east shore in 1 foot of water, Camden Lake, 16 Sep 1970, *Mossman 483* (OS). MIAMI CO.: In deep water, Silver Lake, 2 mi w of New Carlisle, 5 Jul 1925, *Leonard & Leonard 5624* (US). OTTAWA CO.: West Harbor, 2 Aug 1894, *Moseley* (BGSU); Put-in-Bay, Aug 1898, *Pieters* (MICH, US); East Harbor, 7 Jul 1939, *Core* (FTSL); Squaw Harbor, South Bass Island, 31 Jul 1940, *Meyers* (WVA); East Harbor, 11 Aug 1949, *Core & Verduin* (FTSL); a few plants in shallow water of limestone quarry at the Roadside Park on the e end of the Marblehead Peninsula, ca ½ mi s of the town of Marblehead, 6 Aug 1967, *Stuckey 4794* (OS); one small colony seen in shallow water on e side of causeway at East Harbor, East Harbor State Park, 14 Aug 1968, *Stuckey 7375* (OS); occasional in water about 4 inches deep about the edges of shallow pools in bottom of limestone quarry, w side of Quarry Road, ca 1 mi sw of the town of Marblehead, 7 Aug 1969, *Stuckey 8225* (MICH, OS); occasional in clear shallow water of pond behind sand beach in marsh along Lake Erie at Lakeview Park, NE ¼ Sec. 5, T6N, R17E, Portage Twp., e edge of Port Clinton, 8 Sep 1969 *Stuckey 8376* (OS). PORTAGE CO.: In water 3 ft deep, Aurora Lake, NW Aurora Twp., 3 Aug 1957, *Herrick* (OS); in shallow water of pond along Rt. 18, 3 mi e of Brimfield, Rootstown Twp., 24 Jul 1960, *Cooperrider* (KE); shallow water at edge of small pond, n of Stark Co. line, 1 mi e of Congress Lake, Suffield Twp., 6 Jul 1960, *Cooperrider* (KE). SANDUSKY CO.: [without locality] 1895, *Guenther* (BGSU). STARK CO.: Jackson Twp., 16 Jul 1939, *Brown* (OS); Congress Lake, 24 Jul 1898, *Kellerman* (OS). SUMMIT CO.: Cuyahoga Falls, 3 Jul 1899, *Kellerman* (OS). WILLIAMS CO.: Nettle Lake, 5 Aug 1899, *Selby* (OS); occasional in shallow water at Mud Lake Bog, ca 1.25 mi sw of Cooney, Northwest Twp., NE ¼ Sec. 33, T9S, R4W, 18 Sep 1967, *Stuckey 6128* (OS); locally common in artificial lake at old sand pit, ca 2 mi nw of Cooney, Northwest Twp., NW ¼ Sec. 21, T9S, R4W, 12 Sept 1967, *Stuckey 5929* (OS). ESSEX CO., CANADA: Rare, one plant seen in water 2 ft deep, North Lagoon, n end of Pelee Island, 17 Aug 1967, *Stuckey 5125* (OS), erroneously identified and cited as *N. guadalupensis* in Stuckey (1968).

Najas marina L.

Najas marina is known in Ohio from only two localities, both in Erie County (fig. 2). Here the plants are rather common in highly calcareous water of several permanent artificial ponds. Although Braun (1967) treated *N. marina* as native to Ohio, this is a European species which is probably of recent introduction since it was not previously reported from this well-studied portion of western Lake Erie in Ohio (Moseley, 1899; Pieters, 1901; Core, 1948; Stuckey, 1968). The earliest known collection is dated 1959. The 1949 report of *N. marina* by Anderson (1950) from Middle Harbor in Ottawa County should probably, on the basis of our detailed floristic surveys and the absence of a voucher specimen, be referred to *N. minor*. The latter has been found at adjacent East Harbor on several occasions since 1949, but *N. marina* has not been found at either locality.

Not only does *Najas marina* appear to be a recent introduction in Ohio, but it also has been reported, in recent years from other nearby states, where it was not mapped by Clausen (1936). The earliest known collection reported for Wisconsin comes from Sheboygan County in 1941 (Ross and Calhoun, 1951) and for Illinois from Lake County in 1964 (Winterringer, 1966). In Michigan, specimens are known from lakes in Montcalm, Newaygo, and Ogemaw Counties as early as

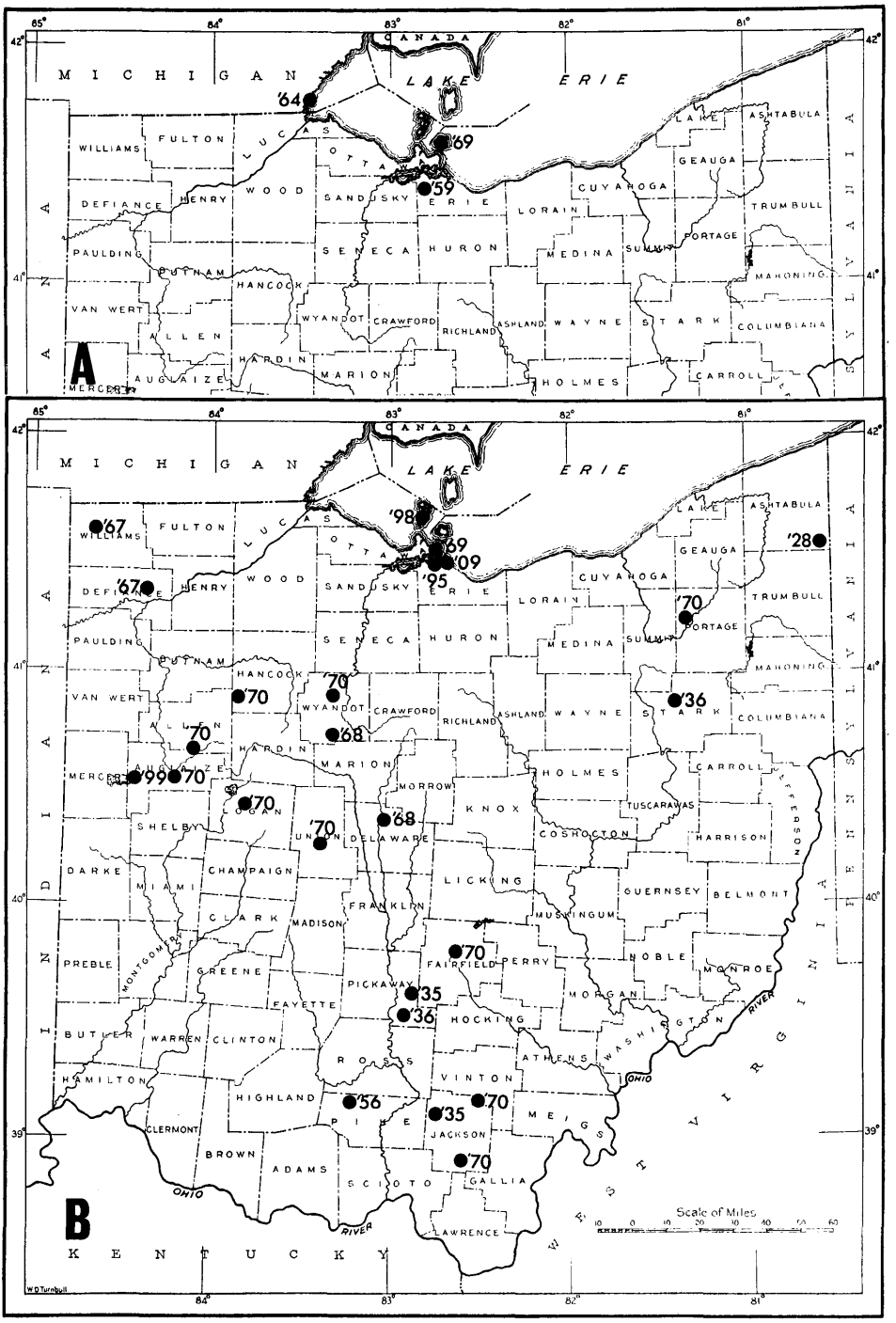

FIGURE 2. Distribution of *Najas marina* (A) and *Najas guadalupensis* (B) in Ohio based on all specimens examined. Each specimen is mapped by a dot at each locality and by the last two digits of the year in which it was collected.

1938–41 (Montcalm Co.: Crystal Lake, 28 Jul 1941, *Roelofs 359*, MICH.; Mud Lake, 30 Jul 1941, *Roelofs 377*, MICH. Newaygo Co.: Brooks Lake, 5 Oct 1940, *Bauzin 2293*, BLH, MICH, MSC. Ogemaw Co.: Peach Lake, 29 Jun 1938, *Locke 32*, MICH). On his 1940 specimen (at MICH) from Brooks Lake, Bauzin noted, "It is slowly replacing other plants in the lake." Later Michigan records come from the Erie Shooting Club Marsh at the west end of Lake Erie in Monroe County (6 Aug 1964, *King*, MICH) and from a marl pool, T14N, R3W, Sec. 6, south of airport, Mt. Pleasant in Isabella County (15 Oct 1964, *Hohn* CMC 4575). The collections of *N. marina* from these three Great Lakes states also suggest recent introduction and establishment of this plant.

Ohio specimens examined:

ERIE CO.: Near shore of man-made ponds in Resthaven Area, not abundant, 14 Jul 1959, *Fisher 1829* (OS); in shallow water, Resthaven Wildlife Area, 22 Aug 1961, *Pinkava 6196* (OS); locally common in marl pond, n portion of Resthaven Wildlife Area, Margaretta Twp., ca 1.5 mi n of Castalia, 4 Oct 1968, *Stuckey 7985* (OS); one small colony seen, clear water ca 1.5 ft deep rocky bottom covered with ca 4 inches silt, permanent pond in West Quarry, south central portion of Kelleys Island, 14 Aug 1969, *Haynes 3219* (OS); locally common in shallow water on s edge of marl pond on w side of N–S road in the sw corner of the Resthaven Wildlife Area (Castalia Prairie), ca 1 mi w of Castalia, 19 Aug 1969, *Stuckey 8242* (OS).

Najas guadalupensis (Spreng.) Magnus

In Ohio, *N. guadalupensis*, a southern species native to the Western Hemisphere, was mapped by Braun (1967) at scattered locations in southern, southeastern, and eastern Ohio, but she did not show northwestern Ohio specimens collected in 1898 and 1899 from western Lake Erie in Ottawa County and from the St. Marys Reservoir in Auglaize County. Recent collections from central and northwestern Ohio come from large artificial lakes in Defiance and Williams Counties (*Stuckey 5899, 8518, 5257*); from small man-made ponds in Delaware, Ottawa, and Wyandot Counties (*Roberts 835, 829, 805*); and from sites in Auglaize, Fairfield, Logan, and Union Counties (*Haynes 3422, 3470, 3410, 3398*). With an increase in these kinds of habitats (artificial lakes and ponds), this species is becoming more common (fig. 2). *Najas guadalupensis* is also known from man-made lakes and ponds in Illinois (Stookey, Fore, and Mohlenbrock, 1964; Fore and Mohlenbrock, 1966).

Ohio specimens examined:

ASHTABULA CO.: Williamsfield Twp., 20 Aug 1928, *Hicks* (OS). ALLEN CO.: Abundant in small farm pond, SW ¼ Perry Twp., ½ mi n of county line road on McClain road, 8 mi s of Lima, 18 Sep 1970, *Roberts 835* (OS). AUGLAIZE CO.: [St. Marys] Reservoir, 13 Aug 1899, *Duvel* (OS); St. Marys, 3 Sep 1900, *Wetzstein* (OS); extremely abundant in artificial marl pond formed by fill being removed for free way (US 33), Sec. 5, Pusheta Twp., at city limits of Wapakoneta, 1 Sep 1970, *Haynes 3422* (OS). DEFIANCE CO.: Common in shallow water on w shore of Oxbow Lake, Tiffin Twp., E ½ Sec. 31, T5N, R4E, ca 6 mi nw of Defiance, 12 Sep 1967, *Stuckey 5899* (OS); [same location], 15 Sep 1969, *Stuckey 8518* (OS). DELAWARE CO.: Common in pond number 1b, se portion of Delaware Reservoir Wildlife Area, Troy Twp., ca 5 mi n of Delaware, 22 Sep 1968, *Stuckey 7967* (OS); common in pond number 14, in ne portion of Delaware Reservoir Wildlife Area, Marlboro Twp., ca 4 mi w of Ashley, 22 Sep 1968, *Stuckey 7968* (OS); [same location], 25 Sep 1969, *Stuckey 8619* (OS). ERIE CO.: Sandusky, 20 Jul 1895, *Moseley* (OS); Cedar Point, 26 Jul 1909, *Schaffner* (OS). FAIRFIELD CO.: Uncommon with *N. minor* in shallow cold water along edge of pond, Greenfield Dam Wildlife Area, Sec. 14, Greenfield Twp., ca 4 mi due n nw of Lancaster, 30 Sep 1970, *Haynes 3470* (OS). HANCOCK CO.: Abundant in fill pond behind Marathon Gas Station at junction of state route 103 and interstate 75, Sec. 7, Orange Twp., 1 mi e of Bluffton, 16 Sep 1970, *Roberts 829* (OS). JACKSON CO.: Liberty Twp., summer 1935, *Bartley & Pontius* (OS); common in Jackson Lake on e side near state route 279, Jackson Lake State Park, Sec. 14, Jefferson Twp., 2 mi w of Oak Hill, 15 Sep 1970, *Roberts 799* (OS). LOGAN CO.: Uncommon in shallow water along small artificial pond surrounded by relatively new housing allotment, McArthur Twp., ca 1½ mi se of Huntsville along US route 33, 1 Sep 1970, *Haynes 3410* (OS). OTTAWA CO.: Put-in-Bay, Jul 1898, *Pieters* (MICH, US); occasional in water about 4 inches deep about the edges of shallow pools in bottom of limestone quarry, w side of Quarry Road, ca 1 mi sw of the town of Marblehead, 7 Aug 1969, *Stuckey 8226* (MICH, OS). PICKAWAY CO.: Washington

Twp., 28 Sep 1935, *Bartley & Pontius* (OS); shallow water at Davenport Pond, Pickaway Twp., 18 Jul 1936, *Bartley & Pontius 103* (NY). PIKE CO.: Shallow water, Pike Lake, 17 Oct 1956, *Braun* (OS). PORTAGE CO.: Abundant in shallow water along shore of Twin Lakes, Franklin Twp., in the village of Twin Lakes, 8 Sep 1970, *Haynes 3443* (OS). STARK CO.: Meyer's Lake, Plain Twp., 20 Sep 1936, *Brown* (OS). UNION CO.: Abundant in shallow, murky water along n shore of smaller pond of two calcareous ponds formed as fill was removed for expressway ramp, in nw corner of intersection of US 33 and Ohio route 4 & 245, ca 8 mi e of Logan Co. line along US 33, 1 Sep 1970, *Haynes 3398* (OS). VINTON CO.: One sprig in shallow, cool, clear water along shore of picnic area at Lake Alma State Park, Sec. 29, Clinton Twp., 13 Oct 1970, *Haynes 3499A* (OS). WILLIAMS CO.: Locally common in shallow water of old sand pit, E ½ Sec. 19, T7N, R2E, Superior Twp., ca 4.5 mi sw of Montpelier, 20 Aug 1967, *Stuckey 5257* (OS). WYANDOT CO.: Abundant in small artificial diked pond at Killdeer Plains Wildlife Area, center Sec. 10, T4S, R14E, Pitt Twp., ca 2 mi s of Harpster, 21 Sep 1968, *Stuckey 7953* (OS); uncommon in fill pond at intersection of state route 33 and county road 44 on the Ralph Roszman farm, Sec. 14, Salem Twp., 6 mi se of Carey, 16 Sep 1970, *Roberts 805* (OS).

Najas minor All.

Najas minor, an European species, invaded North America about 40 years ago and is now the most common naiad species in Ohio, where it is known from 40 counties. This species, which thrives in eutrophic waters and tolerates pollution to some degree (Meriläinen, 1968), occurs on mud and silt bottoms in the shallow parts of large rivers, reservoirs, and ponds. The gradual eutrophication of Ohio waters and the creation of numerous artificial lakes and ponds have provided habitats conducive for the invasion, survival, and establishment of *N. minor* throughout Ohio. Many of the more recent collections have come from artificial lakes and ponds which are of recent construction. In Illinois, *N. minor* occurs in similar habitats (Stookey, Fore, and Mohlenbrock, 1964; Fore and Mohlenbrock, 1966).

What was presumably the earliest North American record of *N. minor* was collected by R. T. Clausen in New York's Hudson River at the mouth of the Mohawk River in 1934 (Clausen, 1936). However, two specimens of *N. minor* from a single collection made by Lawrence E. Hicks on 28 August 1932 in Ashtabula County, Ohio, and misidentified until now as *N. marina*, have been found in The Ohio State University Herbarium. Hicks' record verifies that the species occurred a considerable distance farther westward at least two years earlier than previously known. Since 1932, *N. minor* has spread throughout most of Ohio, reaching the southern part of the state in the 1950's and the northwestern part of the state in the 1960's. The majority of the collections of *N. minor* have been made since 1953.

Najas minor shows considerable morphological variation. In particular, young plants are vegetatively similar to and have been misidentified as *N. gracillima*. Young plants of *N. minor* are very limp and flexible, the leaves are generally rather straight and long, the fruits are either not yet formed or are immature, and when the plants are removed from the water, the leaves become matted together. Older plants of *N. minor* are quite stiff, very brittle, and break easily; the leaves are usually somewhat to strongly recurved, the fruits (if present) are usually mature, and when the plants are removed from the water, the leaves retain their spreading position. The young limp plants are usually found early in the season, in late June, July, and early August, whereas the older stiff plants are found later in the season, in late August, September, and October. Although Braun misidentified several July-early August specimens of *N. minor* (limp plants) from southern Ohio as *N. gracillima*, she properly identified September-October specimens (stiff plants) from the same area as *N. minor*. We have observed a few early-season plants with the limp, flexible appearance, but all of these have had fruits sufficiently mature to verify that they are indeed *N. minor* (examples of these specimens are *Braun* 15 Jul 1960, *Cusick* 27 Jul 1963, *Hawk 138*, *Stuckey 7643*, all at OS). Field observations, comparisons of many herbarium specimens, and collections of plants

at regular intervals from two locations (at the Delaware Wildlife Area, Delaware County, by Mr. Roland G. Hawk, and at East Harbor State Park, Ottawa County, by Ronald L. Stuckey) have revealed that these morphological changes occur in populations and/or clones of *N. minor* throughout the growing season. Meriläinen (1968) has listed the distinguishing morphological characters of *N. minor* and *N. gracillima*.

The distribution of *N. minor* in North America has been mapped by Meriläinen (1968). His map shows that the species is scattered in six areas of eastern North America, and that it is very common in the lower two-thirds of Illinois, but is absent from Ohio and Indiana. The concentration of records for Illinois is probably the result of the recent survey of aquatic plants in that state (Winterringer and Lopinot, 1966). With the now-added distribution for Ohio (fig. 3), this leaves Indiana and the states surrounding Ohio and Illinois with few or no records. We have checked the specimens of *Najas* in the Indiana University Herbarium and

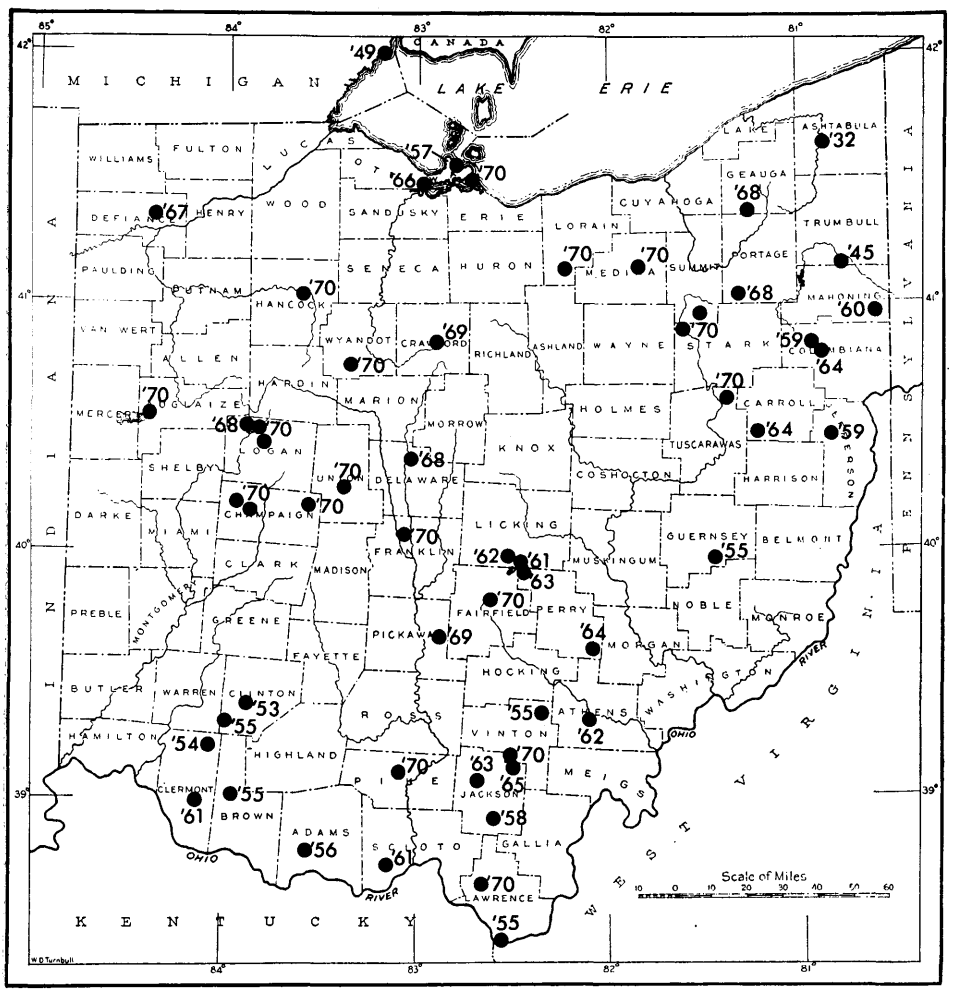

FIGURE 3. Distribution of *Najas minor* in Ohio based on herbarium specimens examined. Each specimen is mapped by a dot at each locality and by the last two digits of the year in which it was collected.

have found no Indiana records of *N. minor* there, although there are several collections known from Knob Lake (7 Sep 1958, *Starcs 2123*, BUT; 7 Sep 1960, *Starcs 2121 a&b*, BUT, OS; 30 Aug 1970, *Starcs 3108a*, BUT) and Starve Hollow Lake (4 Oct 1959, *Starcs 2207*, BUT, OS; 30 Aug 1970, *Starcs 3111*, BUT) of Jackson County in southern Indiana. Meriläinen (1968) calls attention to the absence of *N. minor* from Wisconsin, where he had access to field data and herbarium records. The species is apparently rare in Michigan, where it is known from specimens obtained in only one locality (Pt. Mouillee State Game Area, Lake Erie, Monroe County, 5 Aug 1949, *McDonald 5318*, MICH, MSC, and 28 Jul 1950, *McDonald 5783*, MICH, MSC). The general distribution pattern that is becoming apparent suggests that *N. minor* is invading and is becoming established in east-central United States where the waters of the streams, ponds, and lakes are commonly warmer, muddier, and more turbid than are the cooler, clear waters of the northern streams, ponds, and lakes in Wisconsin and Michigan. The species is probably more common in Indiana than known records show, and plants should be sought in nearby states to the south.

Ohio specimens examined:

ADAMS CO.: Tiffin Twp., 10 Oct 1956, *Braun* (OS); shallow water, Lake Adams, Tiffin Twp., 15 Jul 1960, *Braun* (OS). ASHTABULA CO.: Lake Cardinal, 28 Aug 1932, *Hicks* (OS). ATHENS CO.: Floating in 2 feet of water, pH 7.9, Athens Country Club Pond, 15 Nov 1962, *Blickle* (BHO). AUGLAIZE CO.: Uncommon in muddy water ca two feet deep of pools at Lake St. Marys Fish Hatchery, Sec. 8, St. Marys Twp., 2 mi due sw of the town of St. Marys, 1 Sep 1970, *Haynes 3424* (OS). BROWN CO.: Shallow water, Lake Grant, Pike Twp., 12 Sep 1955, *Braun* (OS). CARROLL CO.: In thick tufts, edge of Leesville Lake, n fork, Camp Aldersgate, Orange Twp., 2 mi nw of Palermo, 11 Sep 1964, *Cusick* (OS). CLERMONT CO.: Stonelick Lake near Edenton, 13 Sep 1954, *Braun* (OS); shallow water, Stonelick Lake, 24 Sep 1958, *Braun* (OS); Stonelick Lake, near Edenton, Wayne Twp., 15 Aug 1960, *Braun* (OS); artificial pond, Tate Twp., ca 2 mi s and 2 mi e of Bantam, 16 Sep 1961, *Weishaupt* (OS). CLINTON CO.: In water, n shore of Lake Cowan, Washington Twp., 1.5 mi nw of Cuba, 28 Aug 1953, *Terrell 2798* (OS); Blanchester, Sep 1955, *Snyder* (OS). COLUMBIANA CO.: Stream flowing through Watercress Marsh, Butler Twp., Sec. 33, 1 mi n of New Garden, 31 Jul 1959, *Cusick* (OS); very common, w tip of Guilford Lake, near shore, Hanover Twp., w of Guilford, 5 Aug 1964, *Cusick* (OS). CHAMPAIGN CO.: Locally common in cool, shallow water of Kaiser Lake, Kaiser Lake State Park, Sec. 22, Johnson Twp., ca 5 mi n ne of St. Paris, 1 Sep 1970, *Haynes 3436* (OS); common in Brush Lake, Rush Twp., ca 3 mi due w of Woodstock along Penn Central R. R. track on county road 130, 16 Sep 1970, *Roberts 849*, 24 Oct 1970, *Roberts 873* (OS); abundant in shallow clear water along shore of relatively new artificial lake surrounded by grazed pasture, Lake Stroman, Concord Twp., ca 3 mi due ne of St. Paris and ca 1 mi e of Millerstown along the road to Eris, 28 Oct 1970, *Haynes 3505* (OS). CRAWFORD CO.: Occasional in water 4 to 6 in. deep of shallow lake along state route 98 at Bucyrus Reservoir No. 1, NW ¼ ca Sec. 32, T17E, R2S, Liberty Twp., ca 2 mi ne of Bucyrus, 5 Sep 1969, *Stuckey 8317* (OS). DEFIANCE CO.: Common in shallow water on w shore of Oxbow Lake, Tiffin Twp., E ½ Sec. 31, T5N, R4E, 12 Sep 1967, 15 Sep 1969, *Stuckey 5900, 8517* (OS). DELAWARE CO.: Common in pond number 1b, se portion of Delaware Reservoir Wildlife Area, Troy Twp., ca 5 mi n of Delaware, 22 Sep 1968, *Stuckey 7965, 7969* (OS); [same location], 15 Oct 1969, *Hawk 138* (OS). FRANKLIN CO.: Ohio State University Conservation Pond near Don Scott Field, Perry Twp., Columbus, 27 Sep 1970, *Storck* (OS). FAIRFIELD CO.: Common in shallow cold water along edge of pond, Greenfield Dam Wildlife Area, Sec. 14, Greenfield Twp., ca 4 mi due n nw of Lancaster, 30 Sep 1970, *Haynes 3468* (OS). GEAUGA CO.: In shallow water at edge of lake along rt. 44, LaDue Reservoir, Auburn Twp., 15 Aug 1968, *Cooperrider* (KE). GUERNSEY CO.: In Seneca Lake, Richland Twp., 15 Sep 1955, *Weishaupt* (OS). HANCOCK CO.: Muddy farm pond in pasture several hundred yards from Blanchard River, NE ¼ Sec. 22, Marion Twp., ½ mi e of Marion Twp., road 208, 3 mi e of Findlay, 16 Sep 1970, *Roberts 825* (OS). JACKSON CO.: Jackson Lake, Liberty Twp., 27 Jul 1958, *Bartley* (OS); area 66 s of lake, in water of Little Raccoon Creek, se of waterworks bldg., Lake Alma State Park, 24 Jul 1965, *O'Dell 1101* (BHO); Hammertown Lake, Liberty Twp., 21 Sep 1963, 28 Sep 1966, *Bartley* (OS); very abundant in water up to 2 ft deep, Jackson Lake, Jackson Lake State Park, Sec. 14, Jefferson Twp., ca 2.5 mi due w of Oak Hill just off state route 279, 15 Sep 1970, *Haynes 3464* (OS). JEFFERSON CO.: Jefferson Lake, Jefferson Lake State Park, Salem Twp., Sec. 18, 2 Jul 1965, *Cusick* (KE). LAWRENCE CO.: In water Ohio River near edge at Burlington, Fayette Twp., 21 Sep 1955, *Weishaupt* (OS); abundant in turbid water up to 2 ft deep in Lawco Lake, Sec. 8, Elizabeth Twp., ca 8/10 mi nw of state route 93 along state route 522, 13 Oct 1970,

Haynes 3482 (OS). LICKING CO.: Floating in cove of Buckeye Lake near Hunt's Landing, abundant, 30 Sep 1961, *Cusick* (OS); Union Twp., Fish Hatchery, 29 Jun 1962, *Truman 62046* (DEN); Union Twp., Rt. 171, 16 Jul 1962, *Truman 62199* (DEN); common in shallow water in dredged area, n of Hunt's Landing at the n end of Buckeye Lake, Licking Twp., ca 2.25 mi se of Hebron, 11 Oct 1968, *Stuckey 7997A, 7997B, 7997D* (OS); extremely abundant in 3 ft. of water in large bay at eastern end of Buckeye Lake, 11 Oct 1970, *Roberts 866* (OS). LOGAN CO.: Common in shallow water and on mud-sand flat in temporary pond on disturbed beach at nw shore of Indian Lake, Indian Lake State Park, Sec. 23, T6S, R8E, ca 1.5 mi ne of Lakeview, 10 Sep 1968, *Stuckey 7643* (OS); locally common in shallow turbid water along shore of Indian Lake on Long Island, ne portion of Indian Lake, along state route 273, ca 3 mi ne of Russells Point. Not seen at this site in previous years, 25 Sep 1970, *Stuckey 9297* (OS); one small colony seen in artificial pond surrounded by relatively new housing allotment, McArthur Twp., 1½ mi se of Huntsville along road to Bellefontaine (US 33), 3 Oct 1970, *Stuckey 9321* (OS). LORAIN CO.: Common in water, 5–12 in. deep over muddy bottom on w side of Findlay Lake, Findlay State Park, NE ¼ Huntington Twp., 2 mi s of Wellington, 19 Sep 1970, *Roberts 760* (OS). MAHONING CO.: In water of Evans Lake, Springfield Road, 2 mi w of New Middleton, 15 Sep 1960, *Cusick* (OS). MEDINA CO.: Abundant in about 12 in. of water along banks in pond along state route 18 on e side of Medina, 21 Sep 1970, *Roberts 855* (OS). OTTAWA CO.: Sandy bottom, 6 to 18 in. of water, East Harbor State Park, 2 Aug 1957, *Cruden 307* (OS); Winous Point, NE ¼ Sec. 21, Bay Twp., 3.5 mi sw of Port Clinton, off St. Rt. 53, 13 Sep 1966, *Lowden 826* (OS); a few plants washed on muddy shore along e side of causeway, East Harbor, East Harbor State Park, 14 Aug 1968, *Stuckey 7379* (OS); common in shallow water on mud flat formed in previous year, East Harbor, East Harbor State Park, 31 Jul 1969, *Stuckey 8216* (OS); rare in shallow water of pond and marsh behind low sand beach at Sand Point, ca 2.5 mi s of the town of Marblehead, 15 Sep 1970, *Stuckey 9222* (OS). PERRY CO.: Floating in Buckeye Lake se of Cranberry Island, Thorn Twp., 27 Jul 1963, *Cusick* (OS); swamp margin, N. Y. Central Reservoir, Corning, 3 Oct 1964, *Perine* (BHO). PICKAWAY CO.: Locally common in shallow muddy water on ne side of Hargus Lake, A. W. Marion State Park, Washington Twp., NE ¼ Sec. 10, T11N, R21W, ca 4 mi ne of Circleville, 20 Sep 1969, *Stuckey 8610* (OS). PIKE CO.: Abundant along e side of Lake White in turbid water with muddy bottom, Pee Pee Twp., ca 2 mi sw of Waverly along Ohio route 104, 13 Oct 1970 *Haynes 3476* (OS). PORTAGE CO.: Common, submerged in 18 in. of water, e of boat dock, Jindra's Landing, w of Rt. 43, 0.5 mi s of Suffield, Suffield Twp., 13 Aug 1968, *Andreas & Greathouse & Zamperini* (KE). SCIOTO CO.: Wolfden Reservoir, Shawnee State Forest, 28 Oct 1961, *Braun* (OS). STARK CO.: Lake along side Ohio and Erie Canal, Lawrence Twp., on e side of old state route 210, 1 mi n of Canal Fulton, 12 Sep 1970, *Roberts 789* (OS). SUMMIT CO.: Abundant in water 3–24 in. deep, bottom sandy-muddy, w side of Nimishilla Lake, Sec. 30, Green Twp., 8 mi s of Akron, 9 Sep 1970, *Roberts 755* (OS). TRUMBULL CO.: Frequent, taken from the intake screen at treating plant, Meander Reservoir, Weathersfield Twp., 27 Aug 1945, *Rood 2621* (KE). TUSCARAWAS CO.: Abundant, submerged in lake, Zoar Wildlife Area, Lawrence Twp., Zoar, 8 Aug 1970, *Cusick, 11,155* (OS). UNION CO.: Uncommon in shallow water along n shore of smaller pond of two calcareous ponds formed as fill was removed for expressway ramp, in nw corner of intersection of US 33 & 36 and Ohio route 4 & 245, ca 8 mi e of Logan Co. line along US 33, 1 Sep 1970, *Haynes 3400* (OS). VINTON CO.: Lake Hope shore, Brown Twp., 19 Sep 1955, *Beatley & Weishaupt* (OS); abundant in shallow clear water near shore of Lake Alma, Lake Alma State Park, SW ¼ Sec. 29, Clinton Twp., ca 1.5 mi due se of Hamden along state route 349, 1 Sep 1970, *Haynes 3463* (OS). WYANDOT CO.: Rare in 6 inches of water of mud bottom pond no. 3, Killdeer Plains Wildlife Area, SW ¼ Sec. 2, Marseilles Twp., ca 3 mi ne of Marseilles, 16 Sep 1970, *Roberts 807* (OS).

SUMMARY

Two general overall trends appear in the changes in the distribution of *Najas* in Ohio. One is the reduction and/or disappearance of the native, northern, cooler and clearer water species, *N. gracillima* and *N. flexilis*. This trend may be expected because there has been an increase in turbidity, a gradual warming, and an overall general eutrophication of Ohio river and lake waters. These new conditions have favored a second trend—the invasion, establishment, and/or spread of the European species, *N. marina*, and *N. minor*, and the southern native species, *N. guadalupensis*. It is probable that similar changes are taking place in the distributions of species of other genera of Ohio aquatic plants.

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